



Lotus Engineering

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Low CO₂ with high performance is affordable and available
 240Nm, 160ps and 15% CO₂ Reduction

Lotus Engineering, the automotive consultancy division of Lotus, and Continental Division Powertrain have presented the results of their “Low CO₂” research collaboration. The Low CO₂ vehicle concept is being proposed as a practical option for manufacturers to reduce their fleet average CO₂ emissions.

The Low CO₂ vehicle concept is demonstrated in an Opel Astra and uses a Lotus Engineering-designed pressure-charged three-cylinder 1.5-litre gasoline engine integrated with a number of Lotus and Continental technologies. It features an innovative integrated exhaust manifold design, centrally-mounted injectors, cam profile switching for lift and timing, a high pressure fuel pump, and a mild hybrid drive. The Low CO₂ Astra produces a g/km CO₂ reduction of **15%** against the naturally aspirated 1.8 litre 4 cylinder engine version of the same vehicle. While forging comparisons to the most frugal B-segment cars, the Low CO₂ Astra – on the NEDC (New European Driving Cycle) – produces performance figures that are comparable to market leading C-segment cars with larger engines.

Comparison Table

Performance Data			
	g/km CO ₂	Torque	Power
Lotus/Continental Low CO ₂ 3 Cylinder 1.5L Opel Astra	149	240 Nm / 177 lbft	160 PS / 118 kW / 158 hp
Opel Astra 4 Cylinder 1.8L *	175	175 Nm / 129 lbft	140 PS / 103 kW / 138 hp
Typical 4 Cylinder 2.2L DI Engine	Not Applicable	220 Nm / 162 lbft	155 PS / 114 kW / 153 hp
Relative Improvement demonstrated by Lotus/Continental Low CO ₂ Concept			
Improvement of Low CO ₂ concept compared with:			
Opel Astra 4 Cylinder 1.8L	15%	36%	14%
Typical 4 Cylinder 2.2L DI Engine	Not applicable	9%	3%

*Official Opel Technical Data





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The primary objective of the Low CO₂ project was to deliver greatly reduced CO₂ emissions while maintaining an engaging driving experience from an affordable set of technologies. The solution employs a cleverly integrated set of powertrain systems within a downsized overall package.

The collaboration concluded in early February with the completion of extensive dynamometer and road testing at Continental’s facility in Toulouse, France and Lotus Engineering’s Hethel Headquarters in the UK. The programme was grant-aided through the UK’s Energy Saving Trust’s Low Carbon R&D Programme funded by the UK Government’s Department for Transport.

Mike Kimberley, Chief Executive Officer of Group Lotus plc, said: “Through intelligent integration of a range of proven and newly available technologies, we have delivered a car that engages and excites the keen motorist with the superb power and torque figures and crucially has a lower impact on the environment. The most important part of this project is that the solution is a combination of technologies that are available and can be implemented in next generation models and with further work beyond the scope of this initial project, dramatic reductions in CO₂ can theoretically be achieved.

He continued: “I am very pleased with what has been achieved in this project. Lotus Engineering is leading the industry across a number of advanced green powertrain technologies, including electric vehicles, hybrids, bio-fuels and developing more efficient gasoline and diesel engines. We believe a crucial factor in the adoption of green cars in the future will be ensuring they remain fun to drive. This Low CO₂ collaboration with Continental Division Powertrain proves that objective has been reached.”

Dr. Hans Nuglisch, Senior Manager of this Low CO₂ project at Continental Division Powertrain, said: “The cooperation with our partner, Lotus Engineering, has shown once again, that there is still an enormous potential for additional innovation within the internal combustion engine. Obviously electronics and mechatronics are making vehicles more economical without compromising driving fun. Additionally turbo charging combined with direct injection means





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noticeably better fuel economy and lower CO₂ emissions for the gasoline engine. With our advanced expertise in low CO₂ know how, we provide clear benefits for our customers and will further strengthen and improve our role as systems integration experts."

Transport Minister Jim Fitzpatrick said, "I am determined that transport should play its part in tackling climate change, so it is essential that our strategy focuses on driving forward new technologies to make engines greener. This engine is one of the more environmentally-friendly petrol engines around, raising the standard for others to meet. I am pleased the Government was able to support this project through the Low Carbon Research and Development programme and look forward to the day when this type of technology becomes commonplace on our roads"

"With over 20% of the UK's total carbon emissions produced by road transport every year, technological advances in this area are vital," explains Philip Sellwood, Chief Executive of the Energy Saving Trust, which is managing the initiative. "This project is an exciting opportunity for innovative technologies to be developed and showcased."

Lotus brought to the project its world-class powertrain design, development, testing and validation capabilities, with specific expertise in engine downsizing and systems integration. Continental Division Powertrain supplied its extensive experience in powertrain management and control systems, especially in the areas of direct fuel injection systems, hybrid drives, energy management, emission after-treatment and a number of new technologies.

Technical details>>>

Technical specification of the Low CO₂ engine when installed in Opel Astra:

- Cylinders: 3
- Displacement: 1.5 litres
- Bore: 88mm
- Stroke: 82mm
- Compression ratio: 10.2:1





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Fuel pump pressure: 200bar

Emissions (NEDC): 149 g/km CO₂ meeting Euro 5 Emission standards

Max power: 160ps @ 5000rpm

Max torque: 240Nm @ 2500rpm - 4000rpm

Mild hybrid motor output: 12kW

Mild hybrid energy storage system: 60v supercapacitors

Key features of the Low CO₂ engine in detail:

CPS switching tappets:

Lotus Engineering's Cam Profile Switching system incorporates lobed tappets that vary valve lift and timing. The system is produced under licence by INA and features in Porsche products in its 'VarioCam Plus' system.

High pressure fuel pump:

Continental Division Powertrain's single cylinder fuel pump driven directly from the tri lobe cam on the exhaust camshaft.

Fuel injectors:

Affordable, 200bar, solenoid, DI centrally mounted injectors by Continental Division Powertrain.

Smart Coolant Pump and Demand Regulated Intank Fuel Pump:

Continental Division Powertrain's electric water and fuel pumps could save up to 2% of fuel.

Mild Hybrid Drive:

The Continental Division Powertrain system features unique water cooled motor housing to match transmission to engine block.

Integrated Exhaust Manifold:

Lotus Engineering designed and developed a new advanced cylinder head design featuring an integrated exhaust manifold. The production-ready technology can significantly reduce





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manufacturing costs, emissions and weight on most gasoline-engined passenger vehicles. An integrated exhaust manifold has potential to:

- o Reduced parts count: 35% fewer components resulting in lower inventory, production, logistics and aftermarket costs
- o Weight reduction: total system mass reduction of 20% resulting from elimination of separate exhaust manifold
- o Improved engine durability

HOTFIRE

The Low CO₂ project exploits the findings of the HOTFIRE project, a previous research programme led by Lotus Engineering and also including Siemens VDO, Loughborough University and University College London. HOTFIRE, which started in October 2004, was based at Loughborough University to explore a permanent homogeneous charge direct injection strategy through the use of centrally-mounted injectors.

- Ends -

Notes to Editors

High-resolution pictures of the Low CO₂ Opel Astra and engine can be downloaded from the media centre of the official Group Lotus website at <http://www.group Lotus.com/mediacentre>. The image library is for registered users only. Members of the press may register for the media centre.

About Group Lotus plc:

The main operating subsidiary of Group Lotus plc is Lotus Cars Ltd, which has two operating divisions - Lotus Engineering and Lotus Cars. Lotus Engineering is an internationally recognised automotive engineering consultancy based in Norfolk, UK. Global facilities include those in Michigan (USA), Kuala Lumpur (Malaysia), China and offices in Germany and Japan, with rapid expansion in new territories such as South East Asia and the Gulf States.

Lotus Engineering provides comprehensive and versatile consultancy services to many of the world's OEMs and Tier 1 suppliers, offering a full engineering service from initial concept and project design through development and integration of the complete vehicle to meet all worldwide markets and customers to full production. This includes third party 'niche vehicle' engineering and manufacture worldwide.

Lotus Cars builds world class, prestige, high performance sports cars for sale in 37 countries. These include the iconic Lotus Elise, and the Exige and Europa. Lotus is a global high-tech company, expanding rapidly and committed to driving forward technology for both Lotus Cars and its Engineering clients, spearheading research into such areas as hybrids, electric vehicles and renewable fuels.

About Continental Corporation

With annual sales of more than €25 billion (based on 2006 figures), the Continental Corporation is one of the top five automotive suppliers worldwide. As a supplier of brake systems, systems and components for the powertrain and chassis, instrumentation, infotainment solutions, vehicle electronics, tires and technical elastomers, the corporation contributes towards enhanced driving safety and protection of the global climate. Continental is also a competent partner in networked automobile communication. The corporation currently employs approximately 150,000 at nearly 200 locations in 36 countries.





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The Powertrain division within the automotive supplier Continental AG integrates innovative and efficient system solutions throughout the drivetrain in vehicles, which increase vehicle performance and driving comfort while simultaneously lowering fuel consumption and emissions. As a partner of the motor industry, the division produces at over 60 locations worldwide, developing a comprehensive product portfolio that ranges from gasoline and diesel injection systems, to engine and transmission controls and all the way to components and systems for hybrid drives. The division, which contains about 27,000 employees, achieved a sales volume of more than 5 billion Euros based on 2006.

About the Energy Saving Trust

The Energy Saving Trust is one of the UK's leading organisations set up to address the damaging effects of climate change. It aims to cut carbon dioxide emissions - the main greenhouse gas causing climate change - by promoting the sustainable and efficient use of energy.

The Energy Saving Trust is an independent, non-profit making organisation and acts as a bridge between government, consumers, trade, businesses, local authorities and the energy market. It provides impartial information and advice and has a network of advice centres in the UK specifically designed to help consumers take action to save energy.

About the UK Government's Department for Transport

The Department for Transport's aim is transport that works for everyone. This means a transport system which balances the needs of the economy, the environment and society.

The Department for Transport provides leadership across the transport sector to achieve its objectives, working with regional, local and private sector partners to deliver many of the services.

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